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Subject: . Effect of Plug Wrap Caliper on Filter Rod RTD and Weight

In preparation for filter specification changes that will be made necessary due to the company wide use of Modified Laser Mike's for filter rod circumference measurement, the following calculations were performed to determine the effect of plug wrap caliper (thickness) on filter rod RTD and weight.

Previous to the use of porous plug wrap at Philip Morris four filter rod circumferences as measured by pneumatic air gauges were used to produce all brands.

	Filter Rod Circumference	Cigarette Circumference
- Saratoga	21.70mm	22.0mm
- Virginia Slims	22.70mm	23.0mm
- All 100mm Brands	24.45mm	24.8mm
- All 80mm & 85mm Brands	24.70mm	25.0mm

With the introduction of Porous Plug Wrap, an attempt has been made to maintain these circumferences although all measurement devices provided a circumference value other than the actual circumference due to plug wrap porosity.

The modified laser mike will allow the use of these four circumference values as targets for the respective brands once again.

Since filter rod pressure drop is affected by filter rod circumference, plug wrap thickness becomes a factor in determining filter rod RTD and weight.

In theory if one could remove the non-porous plug wrap and measure the circumference of the tow the following circumferences would result:

	Target Circumference with Non Porous Plugwrap	Tow Circumference
- Saratoga	21.70mm	21.44mm
- Virginia Slims	22.70mm	22.44mm
- 100mm Brands	24.45mm	24.19mm
- 80mm & 85mm Brands	24.70mm	24.44mm

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Source: https://www.industrydocuments.ucsf.edu/docs/ljhm0004

Effect of Plug Wrap Caliper on Filter Rod RTD and Weight

The tow circumference is based on a plug wrap thickness of 1.60 mils for Ecusta 648/Schweitzer 650 as reported by Direct Materials' Quality Assurance. The circumference is computed as follows:

$$C = \pi (d_2 - d_1)$$

where $d_2 = \frac{c}{\pi} = 24.7 mm/\pi$

d_1 = Plug Wrap Thickness in mm x 2

$$= 1.6 \text{ mils} \times 2 \times .001 \frac{\text{inch}}{\text{mil.}} \times 25.4 \frac{\text{mm}}{\text{inch}} = 0.8128 \text{ mm}$$

Thus the new circumference is:

$$C = \pi \left(\frac{c}{\pi} - 0.08128mm\right)$$

$$= 24.7 - 0.08128\pi$$

$$= 24.44 \text{ mm}$$

With respect to plug wrap thickness; the following table represents actual plug wrap thickness measurements obtained by Direct Materials' Quality Assurance, on Incoming Materials' checks.

Ranked from non-porous to porous:

Plug Wrap Type	Caliper (mils)
- Ecusta 648	1.56
- Schweitzer 650	1.60
- Ecusta 592	1.98
- Ecusta 612	1.69
- Schweitzer 17M 1	2.15
- Schweitzer 33M 1	2.68

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Effect of Plug Wrap Caliper on Filter Rod RTD and Weight

With the table of Tow Circumferences and the table of Plug Wrap thickness the effect of Plug Wrap thickness on RTD at a given finished filter circumference target can be determined as follows:

Example: Merit K.S. - 100 mm x 24.7 mm

Plug Wrap - Ecusta 648/Schweitzer 650

Filter Rod RTD - 19.5 inches of water (P.D.I.)

Filter Rod dry weight (tow + plug wrap + hot melt)= .735 gpf.

Filter tow weight - (.735 - 0.069695 - 0.0028) = .6625 gtpf.

at a constant filter rod circumference of 24.70 mm the RTD is affected by changing plug wrap as follows:

Ecusta 592 -

new filter circumference due to Ec. 592:

$$C = 24.44 + \left[(\quad 1.98 \times 2) \times 0.001 \frac{\text{inch}}{\text{mil}} \times 25.4 \frac{\text{mm}}{\text{inch}} \right] \pi$$

$$C = 24.76$$

Adjusting the circumference from 24.76 to 24.7 increases the RTD to:

$$\text{New RTD} = 19.5 \times \left(\frac{24.76}{24.70} \right)^5$$

$$= 19.74 \text{ inches of water}$$

In order to maintain a filter rod RTD of 19.5 inches of water and an actual circumference of 24.70mm a tow weight reduction would be necessary if a plug wrap change were made from Ecusta 648 or Schweitzer 650 to Ecusta 592.

Plug Wrap	Caliper (mils)	New Circumference	New RTD	RTD Change from Target
Schweitzer 650	1.60	24.7	19.5	0
Ecusta 592	1.98	24.76	19.72	+ 0.22
Ecusta 612	1.69	24.71	19.54	+ 0.04
Schweitzer 17M 1	2.15	24.78	19.83	+ .33
Schweitzer 33M 1	2.63	24.86	20.14	+ 0.64

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Effect of Plug Wrap Caliper on Filter Rod RTD and Weight

The previous table illustrates that if a finished filter circumference of 24.70 mm is maintained for any thickness plug wrap; as the thickness of the plug wrap increases the filter rod RTD will increase also. In order to maintain a constant filter rod RTD independent of plug wrap thickness, the filter tow weight will have to be decreased as the plug wrap thickness increases.

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